Segmentation and Displacement Partitioning Between Surface Reverse Faults and Blind Thrusts, Western Transverse Ranges, California

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Investigations

Three cross sections (Figure 1, sections A-A', B-B', and C-C') have been retrodeformed to the top of the Saugus Formation (300±100 ka; Lajoie et al., 1982; Levi et al, 1986; K. Lajoie, pers. comm., 1987)). This allows the determination of convergence rates for only the youngest structures formed after the end of Saugus deposition. Cross section E-E' has been completed in first draft by Prof. Huafu Lu of Nanjing University. Cross sections F-F' and G-G' are under construction. A geologic map, structure contour maps, and cross sections of the Piru 7½-minute quadrangle have been completed and are being drafted for submission as an Open-File Report. Mapping of the Piru quad was spot checked, and oil wells were interpreted in preparation for cross section D-D'.

A residual gravity map was acquired from A. Griscom (see Jachens and Griscom, 1985). The residual gravity will be modeled as an independent check of the cross sections A-A' through G-G'.

Results

In the Modelo lobe segment of the San Cayetano fault, south-verging displacement is taken up entirely on the San Cayetano fault and associated folding. To the west, at Red Mountain (Figure 2), displacement is entirely taken up on the Red Mountain fault and associated folding. In between, in the Ojai Valley area (Figure 3), there is no north-dipping reverse fault. Displacement is taken up on a blind thrust. The surface expression of the blind thrust is the south-dipping homocline south of Sulphur Mountain and the Lion fault set (Figure 1) which dips south and extends down into bedding within the homocline, forming a passive backthrust above the blind thrust (Namson, 1987; Huftile; 1988; Namson and Davis, 1988; Huftile, 1991). Between Ojai Valley and the Modelo lobe, there is both the south-dipping homocline and a surface reverse fault, implying that the displacement is partitioned between the two structural types.

At South Mountain, there has been 2.5 km of vertical displacement since the end of Saugus deposition (Yeats, 1988). To the west of South Mountain, post-Saugus displacement decreases to zero. There displacement has been transferred, along a decollement in mudstone of the Rincon Formation, to the Ventura Avenue fold belt.

Horizontal shortening on the three cross sections varies from 5.9 km in the west at Red Mountain (Figure 2), to 4.6-5.7 km at Ojai Valley (Figure 3), and to 6.8 km at the Upper Ojai Valley (Figure 4) since the end of Saugus deposition at 300±100 ka. The cross sections have been retrodeformed showing minimum shortening. Shortening rates vary from 2.2±0.7 cm/y along A-A', to 2.1±0.9 cm/y along B-B', to 2.6±0.9 cm/y along C-C'. This implies an increase in convergence from west to east. The convergence rates are consistent with earlier estimates by Yeats (1981, 1983) of 2.0 cm/y and Rockwell (1983) of 1.7±0.4 cm/y.

Reports

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Figure captions

Figure 1: Index map showing the surface traces of western Transverse Ranges faults and major folds, and cross section locations for this paper, Yeats (this volume), and Yeats and Huftile (this volume). The domain boundary separates late Pleistocene surface reverse fault displacement on the Oak Ridge fault in the east and displacement transferred along a decollement in mudstone of the Rincon Formation to the Ventura Avenue anticline and Rincon anticline. Abbreviations are: CB-Carpinteria basin, UOV-Upper Ojai Valley, ACS-Ayers Creek syncline, RMA-Red Mountain anticline, and VF-Ventura fault.

Figure 2: Cross section A-A'. The top is the interpretation of the present-day structure, and the bottom is retrodeformed to the top of the Pleistocene Saugus Formation, 300±100 ka. The Saugus Formation is lightly shaded and the Oligocene Sespe Formation, near the top of the competent sandstones, is darkly shaded. Abbreviations are: Qs-Pleistocene Saugus Formation, Qca-Pleistocene Casitas Formation, Qmp-Pleistocene "Mudpit Shale", Qsb-Pleistocene Santa Barbara Formation, QTf-Plio-Pleistocene Fernando Formation, Tfr-Pliocene Fernando Formation bearing benthic foraminifera of the Repettian Stage, Tsq-Pliocene Sisquoc Formation, Tm-Miocene

Monterey Formation, Tr-upper Oligocene to lower Miocene Rincon Formation, Tcv-Miocene Conejo Volcanics, Tv-Oligocene Vaqueros Formation, Tsp-Oligocene Sespe Formation, Tcw-Eocene Coldwater Formation, Tcd-Eocene Cozy Dell Formation, Tma-Eocene Matilija Formation, Tj- Eocene Juncal Formation, Tll-Eocene Llajas Formation, Tpl-undifferentiated Paleocene strata, K-Cretaceous, PJF-Padre Juan fault, TCF-Tule Creek fault, APF-Arroyo Parida fault, SYF-Santa Ynez strike-slip fault, SYB-Santa Ynez backthrust, and MCF-Mid-Channel fault. Tcw, Tcd, and Tma together form Upper Eocene (U. Eo.) strata.

Figure 3: Cross section B-B', present-day and retrodeformed to the top of the Saugus Formation. Abbreviations are the same as in Figure 2; Mgr-Mesozoic granite, TT-Taylor thrust, BT-Barnard thrust. Movement on the Taylor thrust is constrained to between 1.3-0.65 Ma by Yeats (1983).

Figure 4: Cross section C-C', present-day and retrodeformed to the top of the Saugus Formation. Abbreviations are the same as in Figure 2; LMA-Lion Mountain anticline, and RS-Reeves syncline.

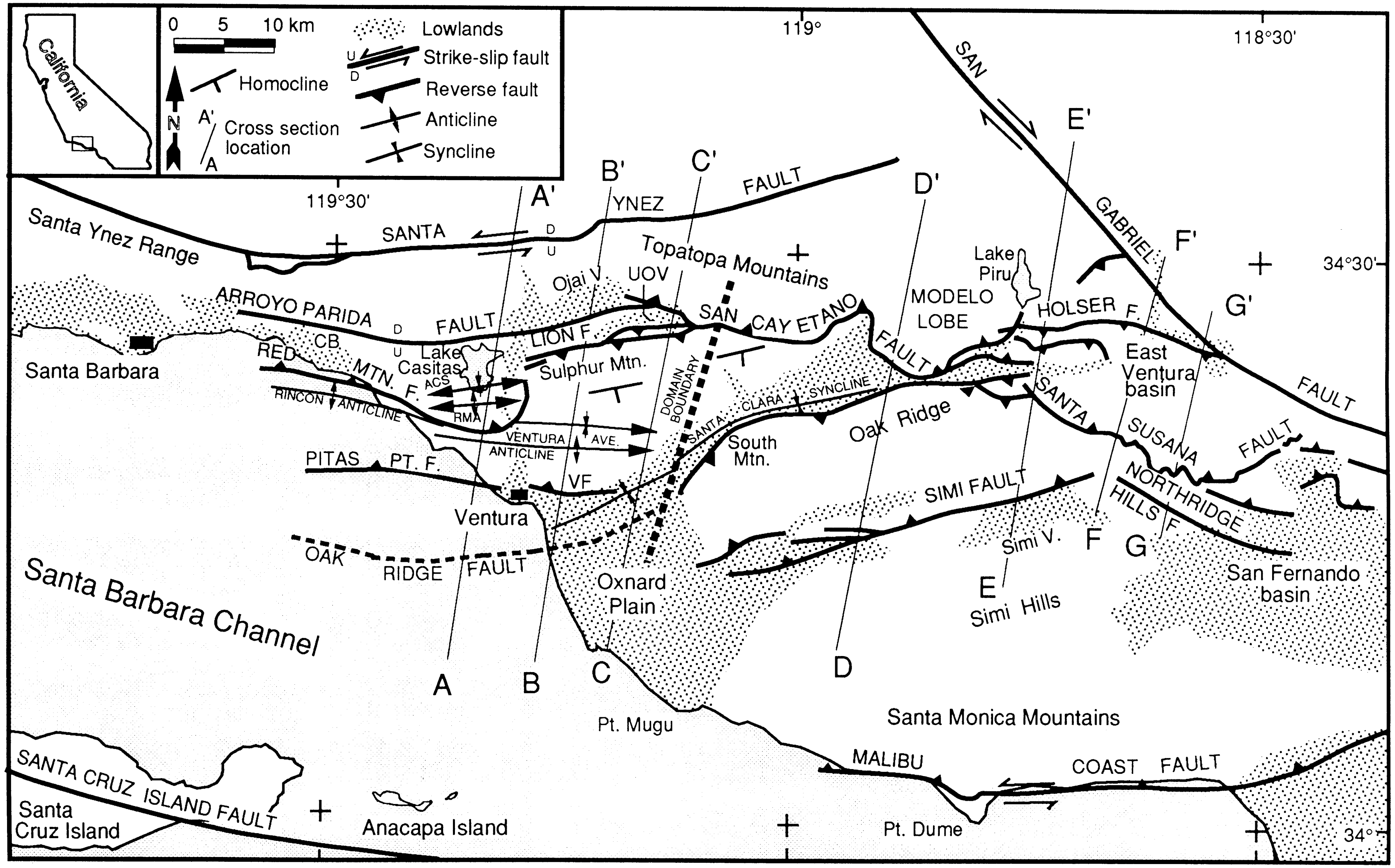

California
0 5 10 km
N
Homocline
A'
A
Cross section location
Lowlands
U
D
Strike-slip fault
Reverse fault
Anticline
Syncline
119°30'
119°
118°30'
34°30'
34°
SAN GABRIEL FAULT
SANTA YNEZ FAULT
Santa Ynez Range
ARROYO PARIDA FAULT
RED MTN. F.
CB
RINCON ANTICLINE
Santa Barbara
Lake Casitas
ACS
RMA
LION F.
Sulphur Mtn.
Ojai V.
UOV
Topatopa Mountains
SAN CAYETANO FAULT
VENTURA ANTICLINE
AVE.
PITAS PT. F.
VF
Ventura
OAK RIDGE FAULT
DOMAIN BOUNDARY
SANTA CLARA SYNCLINE
South Mtn.
Oak Ridge
Oxnard Plain
Pt. Mugu
MODELO LOBE
Lake Piru
HOLSER F.
East Ventura basin
SANTA SUSANA FAULT
NORTHRIDGE HILLS F.
SIMI FAULT
Simi V.
Simi Hills
San Fernando basin
Santa Monica Mountains
MALIBU COAST FAULT
Pt. Dume
Santa Barbara Channel
SANTA CRUZ ISLAND FAULT
Santa Cruz Island
Anacapa Island
A
A'
B
B'
C
C'
D
D'
E
E'
F
F'
G
G'

Figure 1

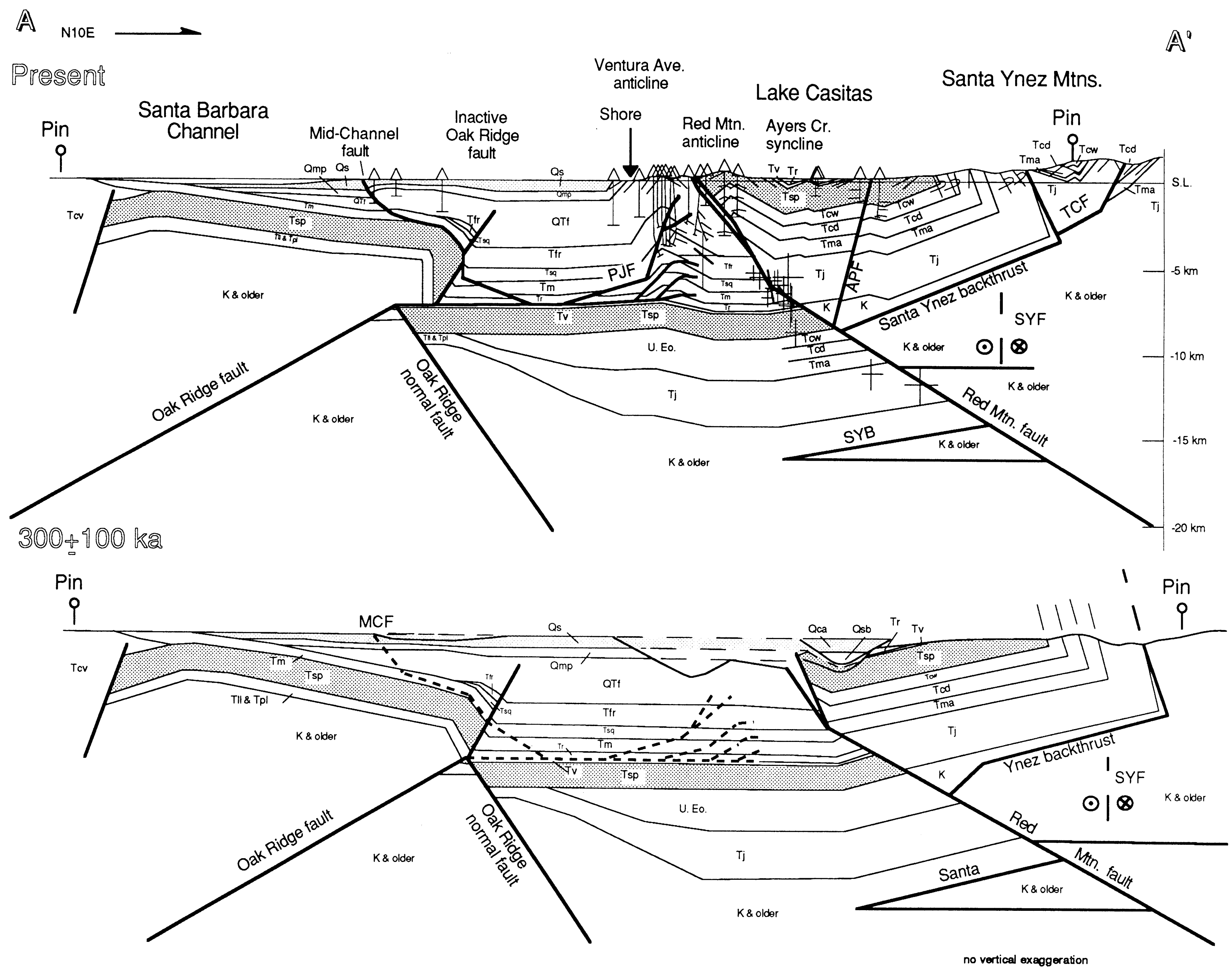
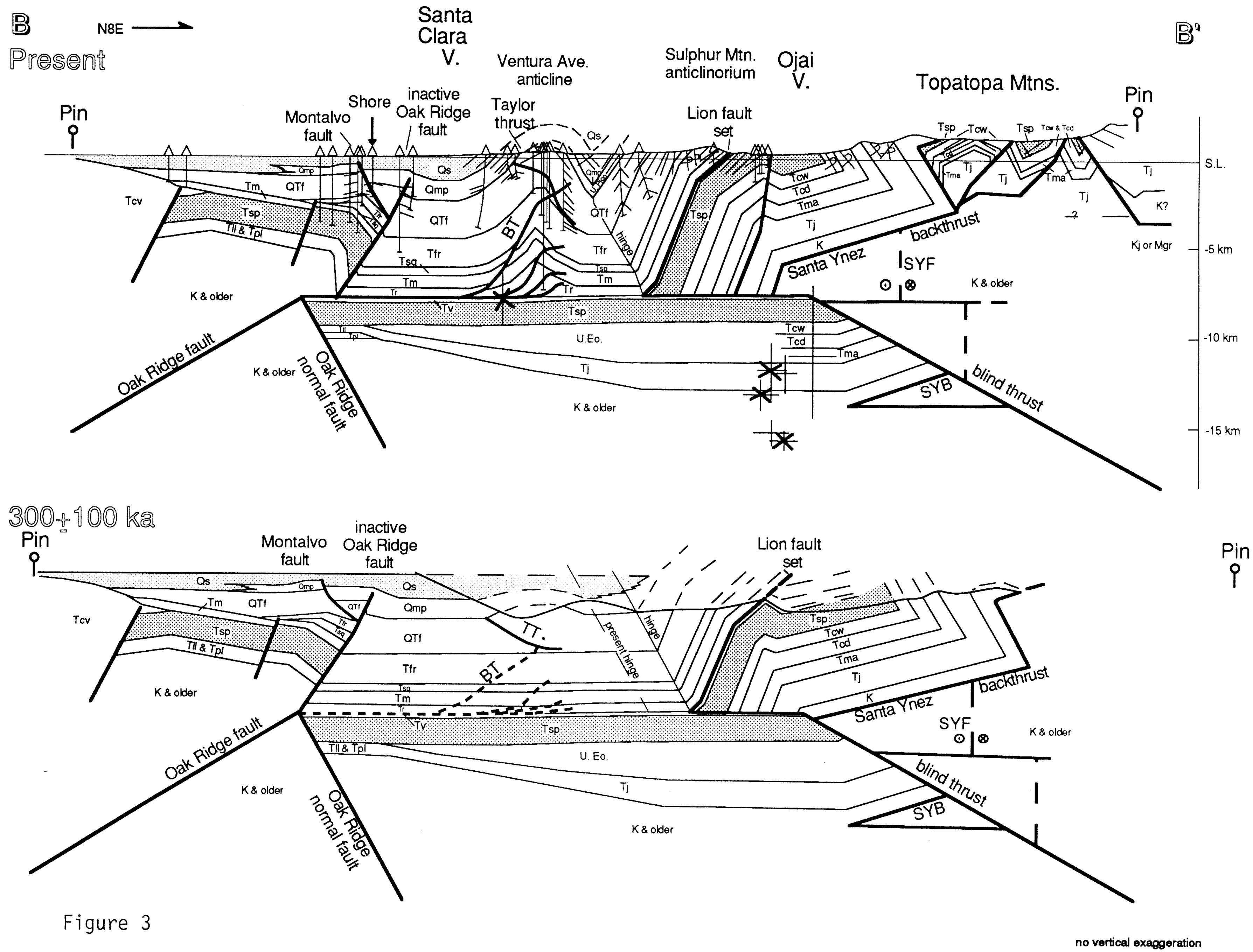

A
N10E
A'
Present
Santa Barbara Channel
Pin
Mid-Channel fault
Inactive Oak Ridge fault
Ventura Ave. anticline
Shore
Red Mtn. anticline
Lake Casitas
Ayers Cr. syncline
Santa Ynez Mtns.
Pin
S.L.
-5 km
-10 km
-15 km
-20 km
Tcv
Tsp
Tm
Qmp
Qs
QTf
Tfr
Tsq
Tr
Tv
Tll & Tpl
PJF
APF
TCF
Tcw
Tcd
Tma
Tj
K
U. Eo.
K & older
Santa Ynez backthrust
SYF
Red Mtn. fault
SYB
Oak Ridge fault
Oak Ridge normal fault
300±100 ka
Pin
MCF
Qca
Qsb
Ynez backthrust
Red
Mtn. fault
Santa
no vertical exaggeration

Figure 2



B
N8E
B'
Present
Santa Clara V.
Ventura Ave. anticline
Sulphur Mtn. anticlinorium
Ojai V.
Topatopa Mtns.
Pin
Montalvo fault
Shore
inactive Oak Ridge fault
Taylor thrust
Lion fault set
S.L.
-5 km
-10 km
-15 km
Qs
Qmp
QTf
Tfr
Tsq
Tm
Tr
Tv
Tsp
Tcv
Tll & Tpl
Tcw
Tcd
Tma
Tj
K
K?
Kj or Mgr
K & older
U.Eo.
BT
hinge
backthrust
Santa Ynez
SYF
SYB
blind thrust
Oak Ridge fault
Oak Ridge normal fault
300±100 ka
TT.
present hinge
no vertical exaggeration

Figure 3

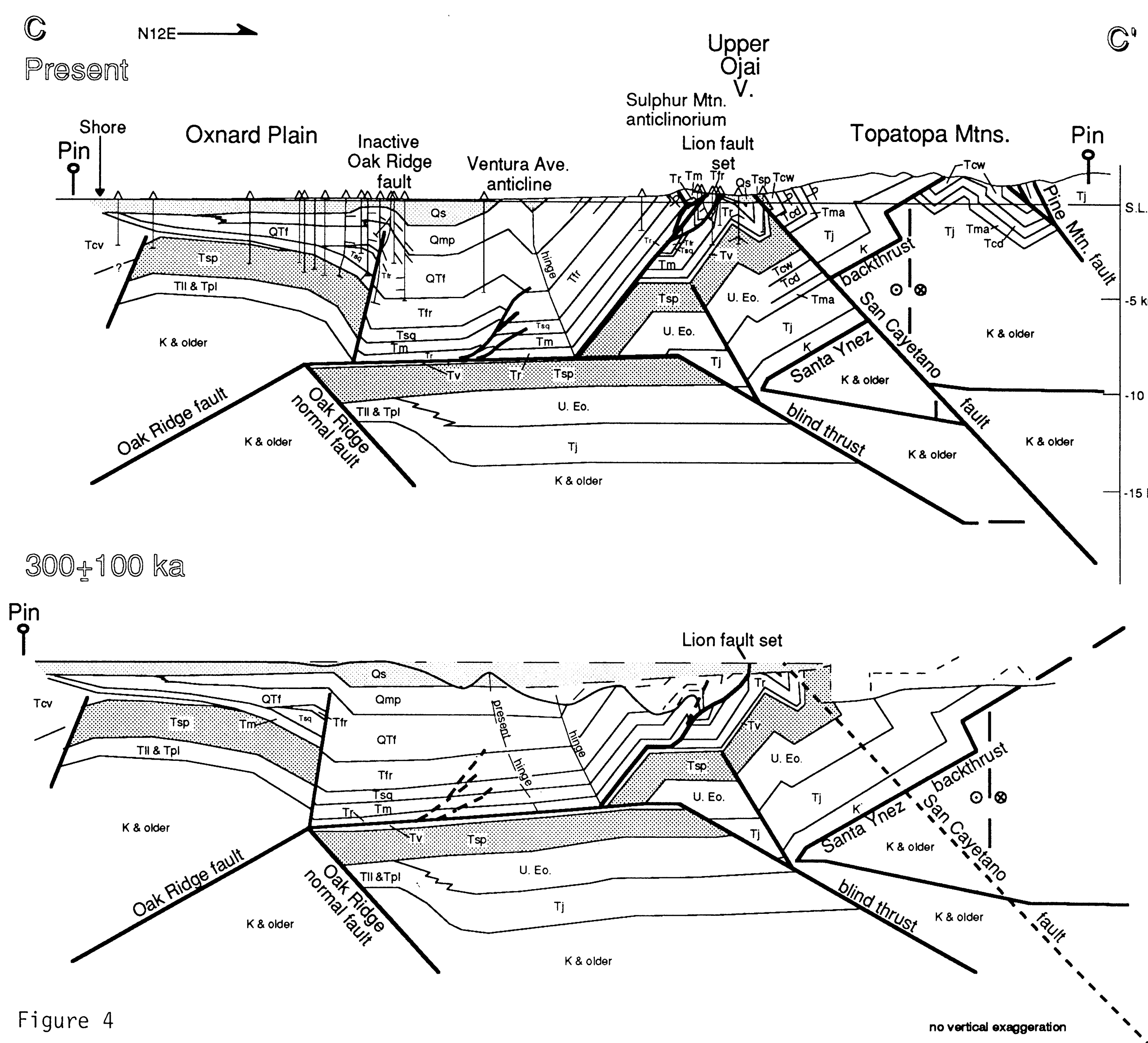

C
N12E
C'
Present
Pin
Shore
Oxnard Plain
Inactive Oak Ridge fault
Ventura Ave. anticline
Sulphur Mtn. anticlinorium
Upper Ojai V.
Lion fault set
Topatopa Mtns.
Pin
S.L.
-5 km
-10 km
-15 km
Tcv
Tsp
Tll & Tpl
K & older
Qs
Qmp
QTf
Tfr
Tsq
Tm
Tr
Tv
hinge
U. Eo.
Tj
Tcw
Tcd
Tma
K
backthrust
San Cayetano fault
Santa Ynez
blind thrust
Pine Mtn. fault
Oak Ridge fault
Oak Ridge normal fault
300±100 ka
Pin
Lion fault set
present
hinge
no vertical exaggeration

Figure 4